

Wide Area Augmentation System (WAAS) – Program Status Update

Presented to: RTCA Working Group 2

By: Jason Burns,

FAA WAAS Space Segment Lead

Date: March 13, 2013



Federal Aviation
Administration



WAAS Architecture



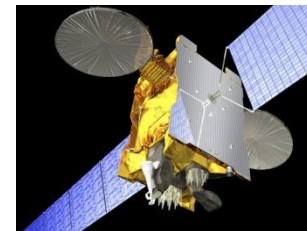
38 Reference Stations



3 Master Stations



6 Ground Earth Stations



3 Geostationary Satellite Links



2 Operational Control Centers

WAAS Status

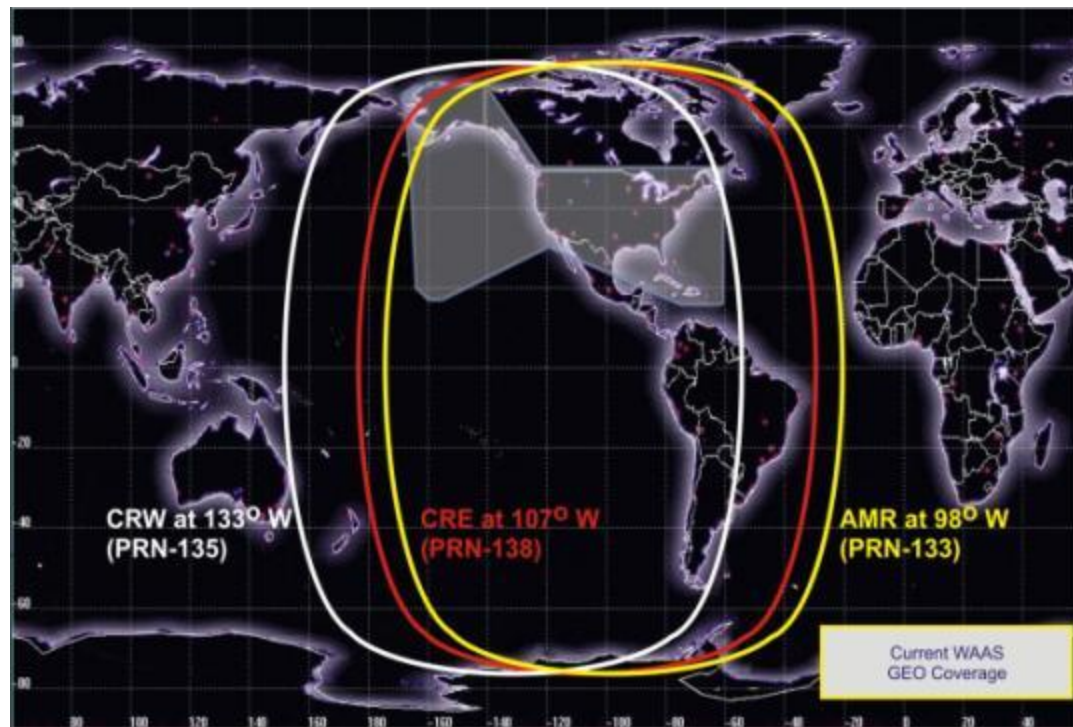
March 13, 2013



Federal Aviation
Administration

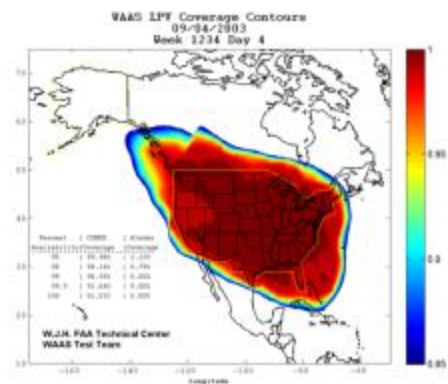
GEO Activities

- **Current WAAS GEO satellites**
 - Intelsat Galaxy XV (CRW)
 - Anik F1R (CRE)
 - Inmarsat I4F3 (AMR) *
- **GEO 5**
 - SIR package released December 2011
 - Contract awarded September 2012

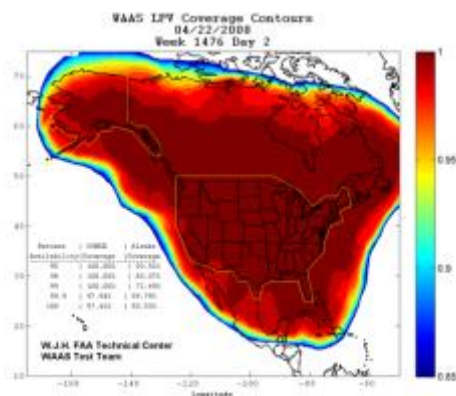


* - *AMR is a non-ranging satellite*

WAAS Coverage

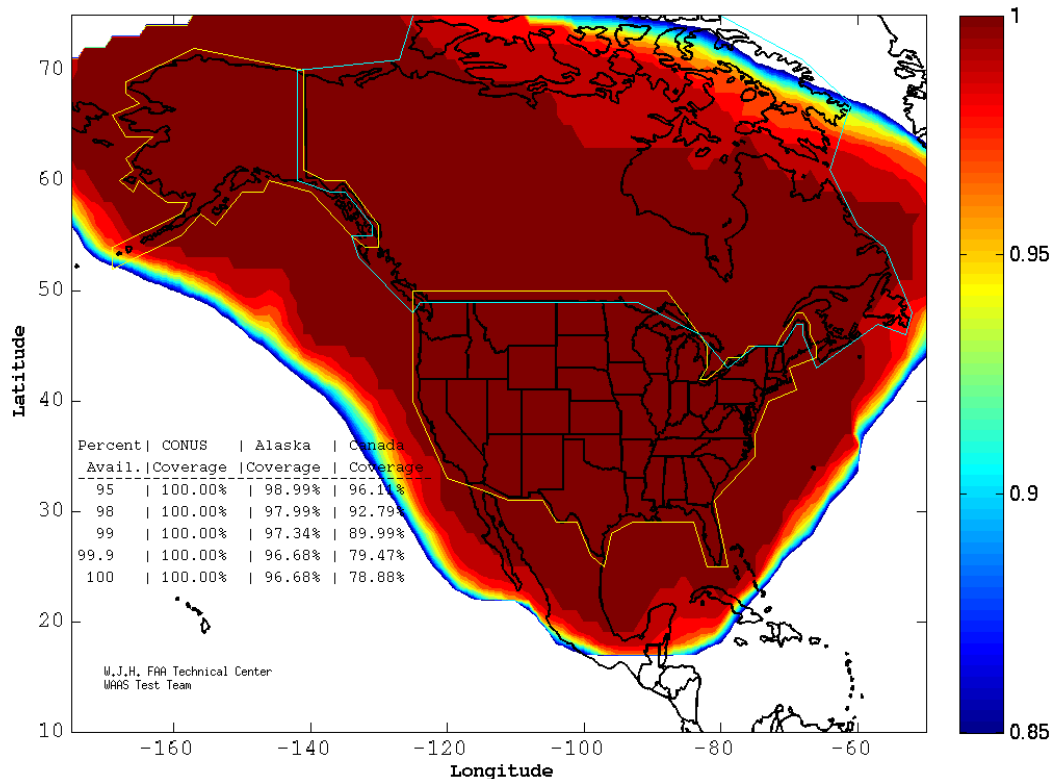


2003 IOC – LPV Coverage in lower 48 states only



2008 Coverage - Full LPV 200
Coverage in CONUS (2 Satellites)

WAAS LPV Coverage Contours
03/06/13
Week 1730 Day 3



2013 Coverage - Full LPV 200
Coverage in CONUS (3 Satellites)

WAAS Status

March 13, 2013



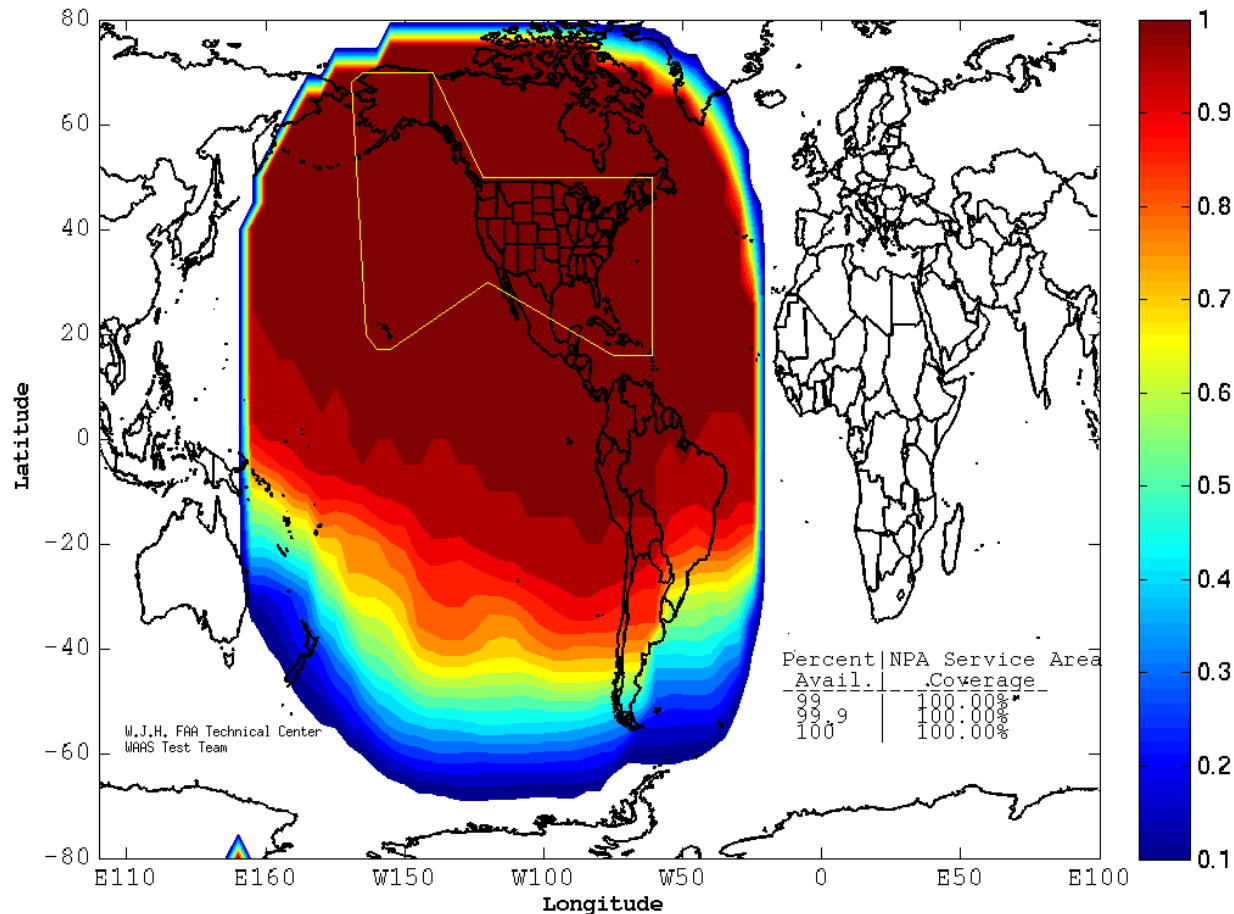
Federal Aviation
Administration

Current WAAS RNP .3 Performance

WAAS RNP 0.3 Coverage Contours

03/06/13

Week 1730 Day 3



WAAS Status

March 13, 2013



Federal Aviation
Administration

WAAS Phases

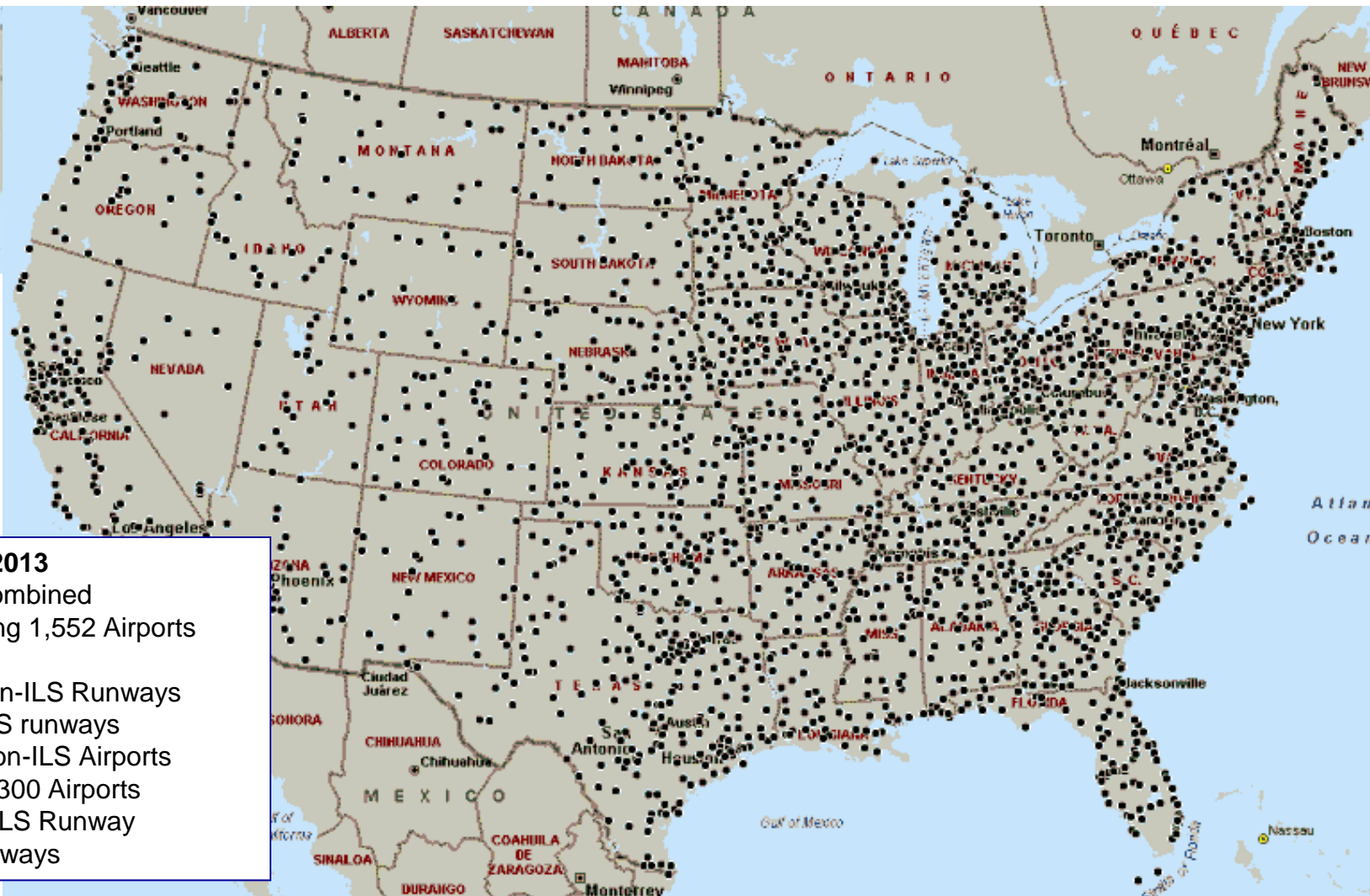
- **Phase I: IOC (July 2003) Completed**
 - Provided LNAV/VNAV/Limited LPV Capability
- **Phase II: Full LPV (FLP) (2003 – 2008) Completed**
 - Improved LPV availability in CONUS and Alaska
 - Expanded WAAS coverage to Mexico and Canada
- **Phase III: Full LPV-200 Performance (2009 – 2013)**
 - Development, modifications, and enhancements to include tech refresh
 - Steady state operations and maintenance
 - Transition to FAA performed 2nd level engineering support
 - Begin GPS L5 transition activities
- **Phase IV: Dual Frequency (L1,L5) Operations (2014 – 2028)**
 - Complete WAAS transition from L2 to L5
 - Commence dual-frequency, iono-free service
 - Improved availability and continuity, especially during severe solar activity
 - Maintain single frequency SBAS service
 - Other capabilities under consideration (see Technology Evolution slide)
 - Will be completed in two segments

WAAS Phase III Ground Segment Development

- **WAAS Release 1 Complete**
 - PCU Upgrade
- **WAAS Release 2 Complete**
 - Release 2A included integration of the AMR GEO in November 2010
 - Release 2B upgraded routers in September 2011
 - Release 2C upgraded PRN (Pseudorandom Noise) Mask Update in August 2011
- **WAAS Release 3**
 - Release 3A implemented ionospheric robustness change in December 2011
 - Release 3B included GUST Upgrades to improve reliability in September 2012
- **WAAS Release 4**
 - Software Build Merge & Code Clean up
 - Build Merge completed in September 2012/ Code Clean-up completed January 2013
 - Final Build Generated February 2013
 - Cutover planned for September 2013



Airports with WAAS LPV/LP Instrument Approaches



As of March 7th, 2013

- 3,512 LP/LPVs combined
- 3,098 LPVs serving 1,552 Airports
- 785 LPV-200' s
- 2,021 LPVs to Non-ILS Runways
- 1,077 LPVs to ILS runways
- 1,357 LPVs to Non-ILS Airports
- 414 LPs serving 300 Airports
- 411 LPs to Non-ILS Runway
- 3 LPs to ILS Runways

WAAS Status

March 13, 2013



Federal Aviation
Administration

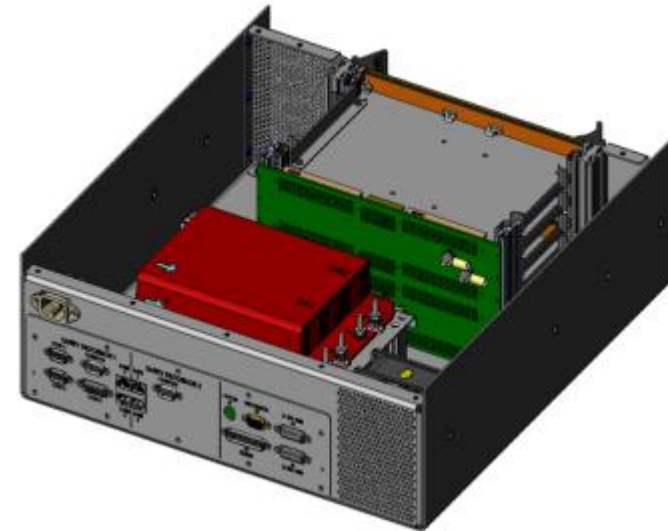
WAAS Reference Receiver (G-III)

- **WAAS program developing next generation reference receiver (G-III)**
- **G-III receiver will add significant new capability and support WAAS dual frequency upgrades in 2014 – 2019 timeframe**
 - Tracks up to 18 GPS satellites and 8 SBAS satellites
 - Capable of tracking GPS L1C/A, L1C, L2C, L2 P(Y), and L5 signal types
 - Expandable to support additional GNSS signals in the future
- **Current Status**
 - Software Development and Hardware Development Completed
 - Factory Qualification Review Completed February
 - Final Software Audit March, FCA/PCA in April
- **Development currently scheduled to be complete in June**
 - ~14 Production Receivers
- **Follow-on contract for production receivers expected 3rd Qtr FY13**
 - ~165 Production Receivers



WAAS Safety Computer

- **The SC adds significant new capability and support to WAAS dual frequency upgrades**
 - The SC will be capable of hosting either WAAS Master Station (WMS) application or the GEO Uplink Station (GUS) without changing the WAAS SC hardware or Infrastructure of software
- **WMS type SCs**
 - Validate corrections messages generated by DO-178B Level D assured software in the WMS Correction Processors (CPs)
 - Preclude broadcast of Hazardously Misleading Information (HMI) to WAAS users
- **Current Status**
 - Preliminary Design Review completed September 2012
 - Critical Design Review, December 2012
 - Testing expected to begin in June 2013
- **Initial Production SC currently scheduled to be complete in FY2013**
 - ~28 Production Safety Computers
- **Follow-on contract for production SC**

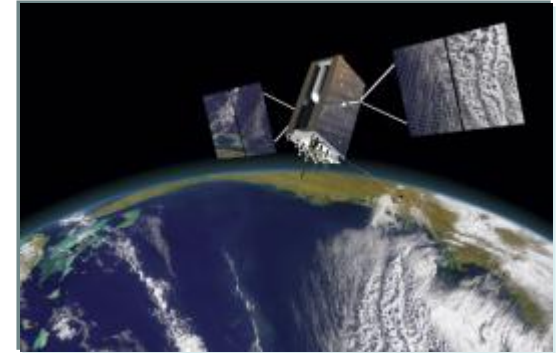


SC Conceptual Design: Rearview

WAAS Communications Upgrade and Dual Frequency Capability

- **WAAS Communication**

- Planning efforts underway to support additional bandwidth and data associated with Dual-frequency WAAS
 - Dual Frequency Trade Study completed December 2011
- Execution by WAAS Operations Team
 - Doubling bandwidth
 - Interface upgrade to 4 wire
 - Technology Refresh of hardware



- **Dual-Frequency Capability**

- Continuing algorithm development
- Working within IWG on definition document
 - Basis for interface design and MOPS development
- Capability follows L5 IOC (L5 IOC expected around 2019)

WAAS Dual Frequency Operations

- **‘Sunset’ of L2 P(Y) compels WAAS to utilize another signal to maintain current service**
 - USG Federal Register Notice states ‘sunset’ for L2 P(Y) signal use in December 2020
- **New dual frequency L1/L5 service needed to further improve WAAS availability and continuity**
- **Segment 1**
 - Develop of infrastructure improvements to support use of L5
 - 5 to 7 year effort
 - G-III Reference Receiver Integration, Communications Upgrade, Safety Computer Integration
- **Segment 2**
 - Implementation of L1/L5 user capability
 - 5 to 7 year effort
 - Dual Frequency Messaging
- **GEO sustainment will occur during both segments**
 - Maintain minimum of dual coverage over WAAS service area

WAAS Technology Evolution

- **Multi-constellation**
 - Development of DFMC definition document
- **Advanced RAIM (ARAIM)**
 - Avionics-centric approach to dual-frequency multi-constellation
 - ARAIM subgroup developing more detailed concept definition
 - Will be used to coordinate standards development with ICAO, RTCA and EUROCAE
- **South America Expansion**
 - Discussing technical options and feasibility within the WAAS program
- **APNT**
 - Review of alternatives / backup when GNSS is unavailable
 - Safe landing, not necessarily to intended destination
 - Industry day held in May 2012
 - Consideration of WAAS Message Type 12 as potential timing source
 - Might need to update MT-12 guidance material
 - Currently reviewing potential of Joint FAA/DoD program of USAF Ultra High Accuracy Reference System (UHARS)
 - Have an Interagency Agreement with Air Force Institute of Technology
 - Determine how a UHARS-inspired pseudolite-system could be best used to meet APNT requirements



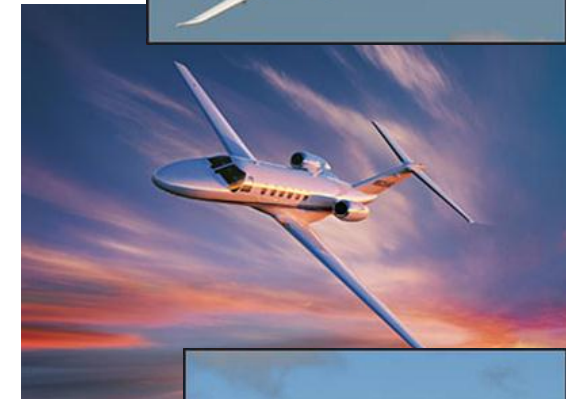
WAAS Avionics Status

- **Garmin:**
 - 79,812+ WAAS LPV receivers sold
 - Currently largest GA panel mount WAAS Avionics supplier
 - New 650/750 WAAS capable units brought to market at the end of March 2011 to replace 430/530W units
- **AVIDYNE & Bendix-King:**
 - 190 Avidyne Release 9 units sold to date. Introduced IFD540 FMS/GPS/Nav/Com System with Touch screen
 - Bendix King KSN-770 certification pending
- **Universal Avionics:**
 - Full line of UNS-1Fw Flight Management Systems (FMS) achieved avionics approval Technical Standards Orders Authorization (TSOA) in 2007/2008
 - 2,688+ WAAS receivers sold as December 5, 2012,
- **Rockwell Collins:**
 - Approximately 2,700 WAAS/SBAS units sold to date
- **CMC Electronics:**
 - Achieved Technical Standards Orders Authorization (TSOA) certification on their 5024 and 3024 WAAS Sensors
 - Convair aircraft have WAAS LPV capable units installed (red label) and received WAAS LPV certification November 2012
 - Canadian North B-737-300 obtained STC for SBAS(WAAS) LPV using dual GLSSU-5024 receivers
- **Honeywell:**
 - Primus Epic and Primus 2000 w/NZ 2000 & CMC 3024 TSO Approval
 - Primus 2000 FMS w/CMC 5024 TSO pending

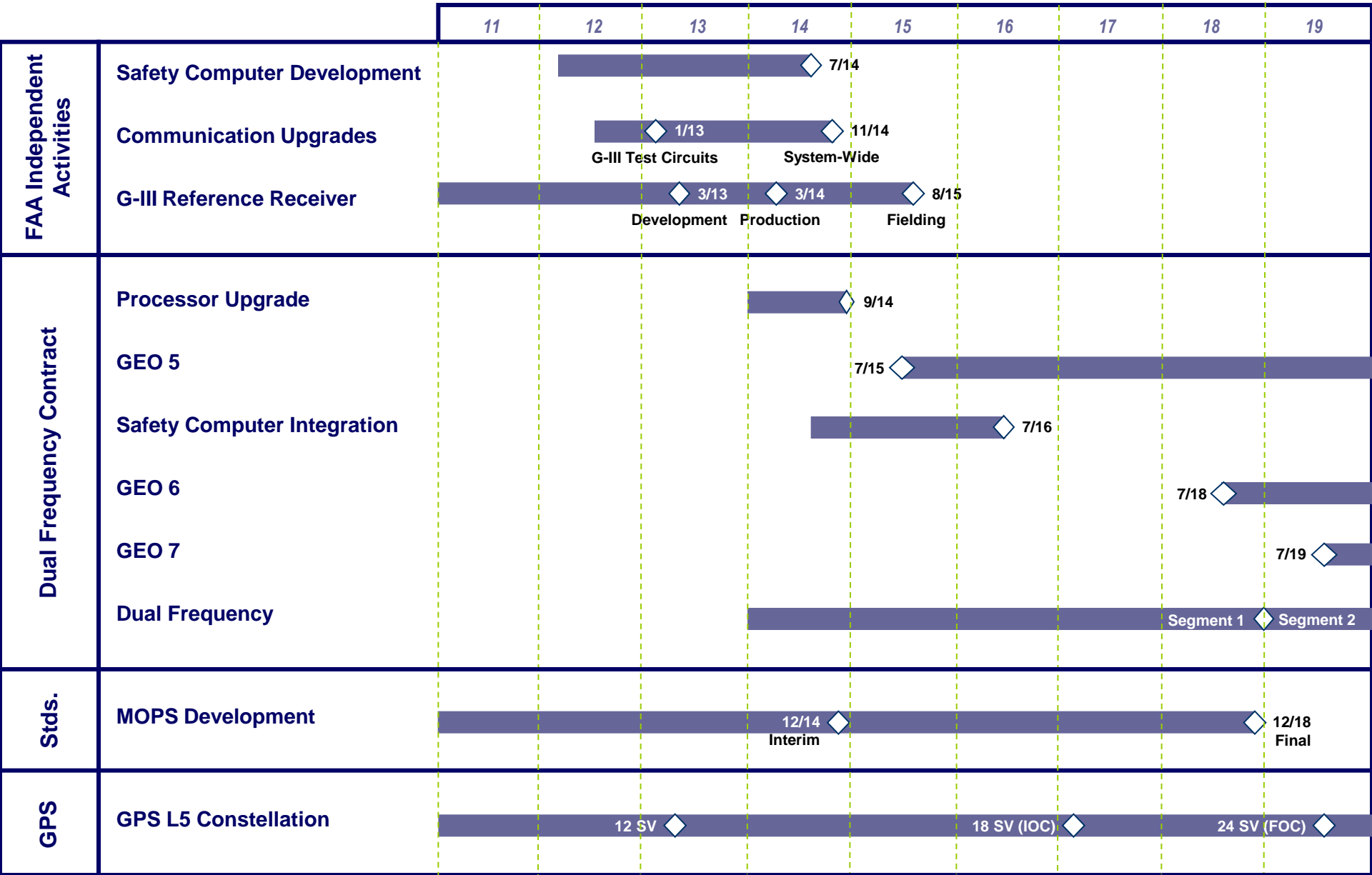


WAAS STC Aircraft Mar 2012 (Estimate)

- **Garmin – 59,993 aircraft**
 - Covers **most** GA Part 23 aircraft.
 - See FAA Garmin Approved Model List (AML)
 - http://rgl.faa.gov/Regulatory_and_Guidance_Library/rgstc.nsf/
- **Universal Avionics – 1,673 aircraft**
 - 121 fixed wing and 12 helicopter types and models
 - Airframes to include (Boeing, de Havilland, Dassault, Bombardier, Gulfstream, Lear, Bell, Sikorsky, etc...)
- **Rockwell Collins – 950 aircraft**
 - 32 types and models
 - Airframes to include (Beechjet, Bombardier, Challenger, Citation, Dassault, Gulfstream, Hawker, KingAir, Lear)
 - Airbus 350 certification pending
- **Honeywell – 450 aircraft**
 - 19 types and models
 - Airframes to include (Gulfstream, Challenger, Dassault, Hawker, Pilatus, Viking)
- **Avidyne – 190 aircraft**
 - 3 types and models (Cirrus, Piper Matrix, and EA-500)
 - 300 IFD 540 WAAS LPV units pre-sold (STC Pending – June 2013)
- **Innovative Solutions & Support (IS&S) – 200 aircraft**
 - Eclipse 550/500
 - Boeing 737-400 (Pending)
- **Cobham (Chelton) – 211 aircraft**
 - Multiple types and models (Bell-407, Bell -412, Cessna 501, 550, Eurocopter AS-350, Piper PA-42, Beechcraft C-90&A, Agusta AW109SP)



WAAS High Level Schedule Activities





Questions

WAAS Status

March 13, 2013



Federal Aviation
Administration